ANSI/RVIA LV

Standard for Low Voltage Systems in Conversion and Recreational Vehicles

2020

Recreation Vehicle Industry Association
1899 Preston White Drive, Reston, VA 20195-0999

The Information Appearing on this Page is NOT Part of the Standard

ANSI/RVIA LV

Standard for

Low Voltage Systems

in Conversion and Recreational Vehicles

Origin and Development of ANSI/RVIA LV

Low voltage electrical standards for the conversion vehicle industry were non-existent prior to the development of this standard. The low voltage electrical requirements of the National Electrical Code NEC (ANSI/NFPA 70) found in Article 551 were used for conversion and recreational vehicles in the late 1980's and early 1990's. However, it was soon determined that the requirements of the NEC did not allow the conversion vehicle manufacturer and the original chassis manufacturer to design and interface low voltage systems that were totally compatible.

To address the low voltage systems in conversion vehicles, representatives of the automotive companies, the conversion vehicle industry, state enforcement administrators and other interested parties reviewed all known low voltage standards and developed the first low voltage electrical standard for conversion vehicles. The first edition was published as a 1992 edition.

The 1995 edition contained several minor changes and classifications that further enhance electrical safety and design.

The 1998 edition was a one page addendum that was a reaffirmation of the 1995 edition with four minor changes, distributed in a one sheet addendum.

The 2000 edition was revised to include recreational vehicles and also contains several minor changes and classifications that further enhance electrical safety and design.

The 2005 edition contains several major changes, such as requiring listed conductors, and many other minor changes that further enhance electrical safety and design.

The 2008 edition contains several major changes such as exempting braking and exterior lighting circuits from conductor listing requirements. Also revised light fixture requirements to address when in close contact with combustible material. Several other minor changes are also included.

The 2011 edition contains several major changes such as removing "solid wire" types from Table 1 an also revising light fixture requirements that are in close contact with materials having a flamespread index of 26 or more. Several other minor changes are also included.

The 2014 edition contains several major changes such as the actual ANSI designation from "12V" to "LV" in order to match the title of Low Voltage (LV) Systems. In addition, conductor routing of 12V and 120V in parallel now will be allowed and a new section has been added to address light fixture criteria when installed above a mattress. Several other minor changes have been made relating to the revision of the base RV definition and moving RV entity definitions to Appendix 3.

The 2018 edition contains several major changes such as addressing the installation of lithium type batteries. In addition a new requirement has been added to require conductor insulation to be continuous between terminals. Several other minor changes such as revising NEC code references and editorial changes that will provide more clarity have also been included.

The 2020 edition contains new requirements for addressing the installation of solar panels and lithium battery systems. Also, the definition of low voltage (LV) was increased to 60 volts DC nominal. Section 4-3 Sizing and respective TABLE 3 CIRCULAR MIL AREA MINIMUM SIZES have been deleted since the wire industry has moved to measuring DC resistance on conductors instead of applying CMA. Several other minor changes are also included.

Statement on Development Procedures

This standard was developed under the published procedures of the American National Standards Institute, Inc. utilizing the canvass method for developing evidence of a consensus. While these procedures assure the highest degree of care, neither the Recreation Vehicle Industry Association, its members, nor those participating in its activities accepts any liability resulting from compliance or noncompliance with the provisions herein, for any restrictions imposed on materials or processes, or for the completeness of the text.

All questions or requests for information on obtaining formal interpretations, proposing amendments and appeals on matter relating to the contents of this document should be directed to the Vice President, Standards, RVIA, Reston, VA 20195-2999.

Accredited Canvass List

2020 Edition

Kent Perkins, Secretary (non-voting)
Recreation Vehicle Industry Association

Brent Chapman, LaSalle Bristol
Jeff Christner, Grand Design
William Conway, Forest River, Inc.
Terry Current, Jayco, Inc.
Harley Holt, Harley Holt & Associates, Inc.
Jerome Hoover, Monaco RV, LLC
Roger Hunt, Lippert Components Inc.
Ryan Hyer, TEi-Listing Services
Tom Knox, Factory Assembled Structures
Von Lindsey, Lindsey Research Services LLC
Mark Luttich, Nebraska Public Service Comm., Housing & Rec. Veh. Dept.
Tony Mikes, Winnebago
Doug Mulvaney, Kampgrounds of America
John Bryan Ritchie, Cummins Power Generation
Tim Schlabach, Thor Industries, Inc.

Contents

Chapter 1 General

1-1 Introduction

NOTICE: An asterisk(*) following the number designation of the paragraph indicating that explanatory material on the paragraph can be found in the Appendix 1, 2 and 3.

1-1.1 Need for Standard. Individuals involved with the manufacture of recreational vehicles, the modification of motor vehicles into conversion vehicles, chassis manufacturers and others associated with safety and inspections have been aware of the need for uniform technical standards. It was also recognized that with the variety of recreational and conversion vehicles being produced, the recreational and conversion vehicle manufacturer and original equipment manufacturer may not be designing low voltage systems that were totally compatible. It was with these factors in mind that this standard has been developed.

1-1.2 Basis for Standards. Much of the material in this standard has been taken from, or is based on recognized standards for low-voltage systems. Documents used are listed in Chapter 9.

1-1.3 Scope. This standard covers the installation of low voltage electrical systems and devices within recreational and conversion vehicles. In the absence of specific instructions from the OEM, this standard also covers any additions, deletions, or modifications to any part of the original equipment chassis manufacturer's electrical system.

1-2*Not Covered. This standard does not cover low-voltage circuits used for signaling purposes only, other low-voltage circuits with a connected load of less than one ampere, those portions of low voltage circuits covered by CFR 49 400-999, and circuits for items listed in Appendix 1.

1-3 Alternate Materials, Equipment, and Procedures. The provisions of this standard are not intended to prevent the use of any material, method of construction, or installation procedure not specifically prescribed by this standard, provided any such alternate is acceptable to the authority having jurisdiction. The authority having jurisdiction shall require that sufficient evidence be submitted to substantiate any claims made regarding the safety of such alternates.

1-4 Limitations. This standard is not intended as a design specification or an instruction manual.

1-5 Differing Standards. Whenever recognized standards and this standard differ, the requirements of this standard shall apply.

1-6 U.S. Federal Regulations. Federal regulations under the National Highway Traffic Safety Administration may supersede all or part of this standard as applied to any category of regulated motor vehicle.

1-7 Definitions. This section contains only those definitions essential to the proper application of this standard. It is not intended to include commonly defined general terms or commonly defined technical terms from related codes and standards.

Accessible: Capable of being removed or exposed without damaging the vehicle or its finished interior or exterior surfaces.

Ampacity: The current in amperes a conductor can carry continuously under the conditions of use without exceeding its temperature rating.

Approved: Acceptable to the "authority having jurisdiction".

Authority Having Jurisdiction: The "authority having jurisdiction" is the organization, office or individual responsible for "approving" equipment, an installation or a procedure.

Automatic: Self acting, operating by its own mechanism when actuated by some impersonal influence, as for example a change in current strength, pressure, temperature, or mechanical configuration.

AWG: American Wire Gage

Battery, Auxiliary: A device for storage of low voltage electrical energy that is installed by the recreational or conversion vehicle manufacturer.

Battery, Source: A device(s) for storage of low voltage electrical energy that is provided and installed by the original vehicle chassis manufacturer.

Bonding: The permanent joining of metallic parts to form an electrically conductive path that will assure electrical continuity and the capacity to conduct safely any current likely to be imposed.

Circuit: The complete path of electric current to and from its power source.

Circuit Breaker: A device designed to open a circuit automatically on a predetermined overcurrent without damage to itself when properly applied within its rating.

Circuit Breaker, Trip-Free: A thermal and/or magnetically operated overcurrent protection device, designed so the resetting means cannot be manually held in to over-ride the current interrupting mechanism.

Circular Mil Area (CMA): The area of a circle as determined by squaring its diameter (in mils). The CMA of any strand of a conductor would be obtained by squaring its diameter (in mils). The CMA of the entire conductor is the total of the CMA's for all the strands contained in the conductor.

Conductor: A substance or body that allows a current of electricity to pass continuously along it.

Conductor, Bare: A conductor having no covering or electrical insulation whatsoever.

Conductor, Insulated: A conductor encased within material of composition and thickness that is recognized as electrical insulation.

Connector: A device that fastens or joins two or more conductors together.

Connector, Pressure (Solderless): A device that establishes a connection between two or more conductors or between one or more conductors and a terminal by means of mechanical pressure and without the use of solder.

Conversion Vehicle: A vehicle that contains the permanent addition to or modification of any item or system from its original state as supplied by the original equipment manufacturer (OEM). This includes the addition of separate, fully independent systems that were not present in the vehicle as supplied by the OEM.

Converter: A device that changes electrical energy from alternating current to direct current.

Device: A unit of the electrical system that is intended to carry but not utilize electric energy.

Equipment: A general term including material, devices, appliances, fixtures, or the like used as part of, or in connection with the electrical system.

Fuse: An overcurrent protective device that incorporates a circuit-opening part that is permanently severed by the heat generated by the overcurrent passing through it.

Fuseblock: Two or more fuseholders sharing the same mounting base, but not necessarily having a common power source.

Fuseholder: A component in which a single fuse is securely held, providing isolation of the source conductor from the distributing conductor.

Ground: The negative terminal of the battery or any conductor or metal current carrying part of the vehicle chassis that is at the same potential.

Grounded: Connected to earth or to some conducting body that serves in place of the earth.

Identified: (As applied to components.) Recognized as suitable for use in conjunction with a specific purpose, use, application, environment, etc.

Inductive Load: Any device that utilizes a process by which electrical energy is utilized to create magnetic forces. (motors, magnetic solenoid)

Listed: Equipment or materials that are included in a list by an organization acceptable to the authority having jurisdiction and concerned with product evaluation, that maintains regular periodic inspections of production of listed equipment or materials, and whose listing of either the equipment or materials meets appropriate standards or has been tested and found suitable for use in a specific manner.

Low Voltage (LV): An electromotive force rated at 60 volts, DC or less.

Original Equipment Manufacturer (OEM): The original self-propelled vehicle chassis manufacturer.

Overcurrent: Any current in excess of the rated current of equipment or the ampacity of a conductor. It may result from overload, short circuit, or ground fault.

Overcurrent Protection Device: A device, such as a fuse or circuit breaker, designed to interrupt the circuit when the current flow exceeds a predetermined value.

Pigtail: Integral external conductors (fixture leads) that originate within an electrical component or device and are supplied by the device manufacturer.

Rating: A value stating the current or voltage carrying capacity of a conductor or device.

Rating, Interrupting: The point of highest current that a circuit breaker or fuse is intended to interrupt under specified test conditions.

Recreational Vehicle (RV)*: A vehicular type unit that is primarily designed as temporary living quarters for recreational, camping, or seasonal use; has its own motive power or is mounted on or by another vehicle; is regulated by the National Highway Traffic Safety Administration as a vehicle or vehicle equipment; does not require a special highway use permit for operation on the highways; and be easily transported and set up on a daily basis by an individual. See Appendix 3 for specific product types and definitions.

SAE: Society of Automotive Engineers.

Shall: Indicates a mandatory requirement.

Terminal: Devices used at the end of a conductor or at a device, for convenience in making connections.

Thermally Protected: A means of protection that opens a circuit when excessive heat is generated.

Utilization Equipment: Equipment that utilizes electric energy for electronic, electromechanical, chemical, heating, lighting, or similar purposes.

Watertight: So constructed that moisture will not enter the enclosure under test conditions specified in NEMA Standard 250. (NEMA 250 is used by ABYC in the Electrical Standards E-8 & E-9.)

Chapter 2 Power Sources

2-1 Power Source. Power source connections shall be accomplished at any of the following or by methods approved by the OEM:

1) Battery terminal or equal

2) Battery cable

3) Starter solenoid

4) OEM Factory-supplied power feed connectors

5) Converter

6) Charge line from tow vehicle

7) Solar panels

2-2 OEM Circuit Extensions. Additions to the OEM wiring system shall be permitted if all of the following conditions are met:

1) It can be documented that the OEM's wiring system can safely support such additional amperage loads.

2) In no case shall the OEM installed overcurrent protection device for any circuit added on to be removed and replaced with one of a higher amperage.

3) Conductors used for the extension of any OEM circuit shall meet or exceed the gage and temperature ratings of the OEM installed conductor. In the event that the OEM wire is not marked with an insulation temperature rating, the vehicle modifier shall meet or exceed the gauge of the OEM wire and verify that the conductor size and insulation rating are permissible on Table 1.

2-3 Auxiliary Battery Installations. Storage batteries shall be securely attached to the vehicle and protected against physical damage. If vented batteries (includes lead acid and sealed lead acid) or vented battery compartments are provided, the battery compartments shall be vapor resistant to the interior and ventilated directly to the exterior of the vehicle. Battery compartments designed for vented batteries shall be ventilated with openings having a minimum area of 1.7 square inches (1097 mm^2) within 2 inches (50.8 mm) of both the top and bottom. Battery compartments designed for vented batteries may be used with vented or non-vented batteries (including lithium) if the compartment is located where it will not impede the safe exit from the vehicle for the occupants should a failure occur in the non-vented battery. Vented batteries shall not be installed in a compartment, hood or housing containing spark or flame producing equipment, except that they shall be permitted to be installed in the engine compartment, or generator compartment if the only charging source is from the engine generator. If provided, battery compartments designed for non-vented batteries only (including lithium) shall be designed such that the mount or compartment shall be incapable of accepting a vented battery, or the system shall be designed electrically to prevent the operation of a vented battery. Non-vented battery installations shall contain a safety protection system.

Compartments, hoods or housings identified or outfitted for the purpose of housing batteries, such as by the presence of battery cables, shall meet or have provisions for meeting the above requirements.

Lithium battery systems shall be listed and conform to the terms of the listing and manufacturers installation instruction.

2-4 Auxiliary Battery Grounding. The chassis-grounding terminal of the battery shall be grounded to the vehicle chassis with a minimum No. 8 AWG copper conductor or equivalent. In the event the power lead from the battery exceeds No. 8 AWG, then the grounding conductor shall be of an equal size.

2-5 Converters. All converters and transformers shall be listed for use in recreational vehicles. Circuits fed from alternating current transformers shall not supply direct current appliances.

To determine the converter rating, the following formula shall be applied to the total connected load, including average battery charging rate, of all 12-volt equipment:

The first 20 amperes of load at 100 percent; plus

The second 20 amperes of load at 50 percent; plus

All load above 40 amperes at 25 percent.

Exception: A low-voltage appliance that is controlled by a momentary switch (normally open) that has no means for holding in the closed position shall not be considered as a connected load when determining the required converter rating. Momentarily energized appliances shall be limited to those used to prepare the vehicle for occupancy or travel.

2-5.1 Bonding Voltage Converter Enclosures. The non-current-carrying metal enclosure of the voltage converter shall be bonded to the frame of the vehicle with a minimum No. 8 copper conductor. The grounding conductor for the battery and the metal enclosure shall be permitted to be the same conductor.

2-5.2 Dual-Voltage Fixtures or Appliances. Fixtures or appliances having both 120-volt and low-voltage connections shall be listed for dual voltage.

2-5.3 Autotransformers. Autotransformers shall not be used.

2-5.4 Receptacles and Plug Caps. Where a recreational vehicle is equipped with a 120-volt or 120/240-volt alternating-current system, a low-voltage system, or both, receptacles and plug caps of the low-voltage system shall differ in configuration from those of the 120- or 120/240 volt system. Where a vehicle equipped with a battery or other low-voltage system has an external connection for low-voltage power, the connector shall have a configuration that will not accept 120-volt power.

2-6 Solar Prep Installations. Solar prep installations shall be permitted if all the following conditions are met:

1) The conductor shall have overcurrent protection that complies with 3-2 thru 3-6.

2) The location for the controller shall be identified.

3) The conductors shall not have exposed ends within the prep installation.

4) The conductors shall be retained within the identified controller location.

5) The conductors for connection to the battery shall be labeled as "+" and "-".

Chapter 3 Circuit Protection

3-1 General. All conductors shall be provided with overcurrent protection.

Exception #1: Solar panel (photovoltaic module) circuits are considered current limiting and overcurrent protection shall not be required for these circuits if the conductors have sufficient ampacity for the largest available current.

Exception #2: Braking circuits, cranking circuits, circuits supplying lights subject to federal or state regulations, and pigtails of utilization equipment less than 10 inches in length are exempt from overcurrent protection requirements.

3-2 Sizing. All overcurrent protection within a low voltage circuit shall be rated not in excess of the ampacity of the conductors shown in Table 1 or Table 2. Overcurrent protection shall be permitted to be specified by the chassis OEM for wiring and devices installed or supplied by the chassis OEM.

TABLE 1
OVERCURRENT PROTECTION
No Wire Bundling Restrictions

Wire Size	Ampacity	Wire Type
20	3	Stranded only
18	6	Stranded only
16	8	Stranded only
14	15	Stranded only
12	20	Stranded only
10	30	Stranded only
8	40	Stranded only
6	55	Stranded only
4	75	Stranded only
2	100	Stranded only

TABLE 2
OVERCURRENT PROTECTION
***Not More Than Seven Wires Per Harness**
****Not More Than Three Wires Per Harness**

AWG OR SAE Conductor Size (Gage)	Maximum Ampacity at Conductor Insulation Temperature Rating of: 90°	Maximum Ampacity at Conductor Insulation Temperature Rating of: 105° C/125° C
20*	5	7.5
18*	7.5	10
16*	10	15
14*	17.5	20
12*	22.5	25
10**	40	50
8**	55	70
6**	75	100
4**	95	120
2**	130	150
1**	150	
1/0**	170	
2/0**	195	
3/0**	225	
4/0**	260	

3-3 Types. Circuit breakers or fuses shall be of an approved type. Circuit breakers shall be of the trip-free type and remain operable (not requiring replacement) after the fault. Circuit breaker or fuses shall have a DC rating not less than the nominal system voltage.

NOTE: For further information, see Society of Automotive Engineers (SAE) Electric Fuses (Cartridge Type), SAE J554; Blade Type Electric Fuses, SAE J1284: Circuit Breakers, SAE J553: Circuit Breakers-Internal Mounted-Automatic Reset, SAE J258; and Underwriters Laboratories, Inc. Standard for Automotive Glass Tube Fuses, UL 275.

3-4 Marking. Fuseholders shall be clearly marked with the maximum replacement fuse size. Circuit breakers shall be clearly marked with their amperage rating.

3-5 Location. The overcurrent-protective device shall be installed in an accessible location on the vehicle within 18 in. (457 mm) of the point where the power source connects to the vehicle circuits.

Exception: External low-voltage supply shall be permitted to be fused within 18 in. (457 mm) after entering the vehicle or after leaving a metal raceway.

3-6 Protection. Fuses and circuit breakers shall be protected against weather and physical damage.

Chapter 4 Low Voltage Conductors

4-1 Materials. Copper conductors shall be used for low-voltage circuits. Low voltage conductors shall be of the stranded type.

Exception #1: Metal chassis or frame of a minimum thickness of at least 0.0548 inches (1.392 mm) shall be permitted as the return path to the source of supply.

Exception #2: Buss bars used in accordance with their installation instructions.

***4-2 Types.** Conductors shall conform to the requirements of SAE Standards J1127 or J1128, or shall have insulation in accordance with NEC Table 310-104(A) or the equivalent. Conductor's sizes 6 AWG through 18 AWG or SAE shall be listed. Conductors shall have a minimum insulation rating of 90°C (195°F) For all engine compartment conductors or for any under chassis installations where conductors are located less than 10 inches from any component of the engine exhaust system the minimum insulation rating shall be 125°C (257°F).*

Exception: Braking circuits, cranking circuits, circuits supplying lights subject to federal or state regulations, and pigtails of utilization equipment less than 10 inches in length are exempt from this requirement.

4-4 Conductor Identification. All insulated low-voltage conductors shall be identified as follows:

a) Listed conductors shall be marked as required by the listing agency.

b) SAE conductors shall be marked as required by SAE.

c) Other conductors shall be marked with temperature rating, wire gauge, conductor material, and insulation thickness.

4-5 Circuit Boards. A printed circuit board used in place of wire shall be identified and marked regarding its maximum ampacity. Printed circuit boards shall be used within their stated ratings.

4-6 Grounded Circuit Identification. All ground returns to chassis or power source shall be uniquely identified as separate from the supply conductors (i.e. color, marking, etc.)

4-7 Other Circuit Identification. Each circuit conductor shall maintain its established identification throughout its run.

Chapter 5 Conductor Protection, Routing and Securing

5-1 Conductor Protection. Conductors shall be protected against physical damage and shall be supported. Where insulated conductors are clamped to the structure, the conductor insulation shall be supplemented by an additional wrap or layer of equivalent material, except that jacketed cables shall not be required to be so protected. Wiring shall be routed away from sharp edges, moving parts, or heat sources.

5-2 Conductor Routing. Direct-current circuits shall be physically separated by at least a 1/2 in. (12.7 mm) gap or other approved means from 120/240 volt circuits. Acceptable methods shall be by clamping, routing, or equivalent means that ensure permanent total separation. The external jacket of the 120/240 volt circuit nonmetallic-sheathed cables and 120/240 volt circuit flexible cords shall be permitted as adequate separation.

5-2.1 Harness. Conductors shall be grouped in harness form where required by the OEM.

5-2.2 Conductor Continuity. Conductor insulation shall be continuous between terminals.

5-3 Conductor Securing

5-3.1 Strain Relief. Conductors connecting components that can move with relation to each other shall be installed with a loop, slack, or other means of strain relief.

5-3.2 Accessibility. At least 4" of free conductor shall be provided after the last point of conductor securement to permit service and accessibility of each device.

5-3.3 Conductor Support. Conductor(s) shall be supported and secured at intervals not exceeding 1.4m (4 1/2 feet).

Chapter 6 Connections

6-1 Conductor Splicing and Terminals

6-1.1 Splicing. Conductors shall be spliced or properly joined with connectors or by soldering.

6-1.2 Tensile Force. Each conductor splice joining conductor to conductor, conductor to connectors, and conductor to terminal shall be able to withstand a tensile force equal to at least the value shown in Table 4 for a one minute duration and not break or separate.

TABLE 4
TENSILE TEST VALUES FOR CONNECTORS

Conductor Size Gage	Tensile Force Pounds
20	5
18	10
16	15
14	30
12	35
10	40
8	45
6	50

6-1.3 Size and Use. All connectors and terminals used shall be identified for the conductor size and type to which they are attached.

6-1.4 Soldered Splices. Splices to be soldered shall be twisted or mechanically secured before soldering.

6-1.5 OEM Connections. Connections to OEM circuits shall be according to OEM specifications.

6-1.6 Wire Nuts. Twist on wire nuts, if used, shall be listed and used within the terms of their listing.

6-1.7 Pressure Connectors. Connections shall be permitted to be made using a set-screw pressure type connector providing the connector is identified for use with stranded wire.

6-1.8 Protection. All splices and joints of conductors shall be covered with an insulation equivalent to that of the conductors being used. Free ends of conductors shall be protected from accidental shorting.

6-1.9 Terminations. Terminations shall be permitted to comply with the requirements of SAE J561, Eyelet and Spade Types; SAE J858, Blade Type; and SAE J928, Pin and Receptacle Type or equivalent.

6-1.10 Material. Metals used for terminal studs, nuts and washers shall be corrosion resistant and galvanically compatible with the conductor and terminal lug.

6-1.11 Mating Terminals. Mating terminals, when assembled, shall be mechanically secure to ensure a proper electrical connection. The hot (supply) side of mating terminals shall be of the insulated receptacle type.

6-1.12 Eyelet and Spade Terminals. Eyelet and captive spade-type terminal connectors and locking washers if used shall be the same nominal size as the stud or attachment case.

6-1.13 Shanks. The shanks of terminals shall be protected against accidental shorting by location or the use of insulation barriers or sleeves, except for those used in the grounding system.

6-1.14 Stacking. No more than four terminals shall be secured to any one terminal stud. If additional connections are necessary, two or more terminal studs may be connected together by means of appropriately sized jumpers or copper straps.

6-1.15 Access. Wiring connections to devices shall be accessible.

6-2 Grounding

6-2.1 Attachment Material. Ground terminal attaching screws, nuts, bolts and lockwashers shall be cadmium, tin, zinc, or equivalently plated.

6-2.2 Terminal Material. Ground terminals shall be copper, copper alloy or other material with equivalent corrosion resistance.

6-2.3 Securement. Ground terminals shall be mechanically secure.

6-2.4 Access. Ground terminals shall be accessible for service.

6-2.5 Electrical Connections. The surface on which ground terminals make contact shall be cleaned and free from oxide or paint, or the terminal shall be electrically connected through use of a cadmium, tin, zinc, or equivalently plated serrated paint cutting terminal, or lockwasher.

Chapter 7 Equipment

7-1 General

7-1.1 Installation. The installation of any equipment or devices shall meet the applicable requirements of this standard and shall be installed according to the manufacturer's instructions. Where the equipment or device manufacturers installation instructions differ from the requirements of this standard, the requirements of this standard shall apply.

Exception: Listed devices shall be installed according to the terms of their listing.

7-1.2 Accidental Shorting. All devices shall be designed and installed so that current carrying parts of the device are protected from accidental shorting.

7-2 Devices

7-2.1 Switches and Relays. Switches and relays shall have DC voltage ratings not less than the system voltage and a current rating not less than the connected load. Switch and relay ratings for tungsten lights and inductive loads shall be not less than 150% of the connected load or as specified by the manufacturer.

7-2.2 Cigarette Lighter Receptacles. Low-voltage receptacles that will accept and energize cigarette lighters shall be installed in a non combustible outlet box or the assembly shall be identified by the manufacturer as thermally protected.

7-3 Utilization Equipment

7-3.1 Lighting Fixtures. All interior low-voltage lighting fixtures shall be listed.

Exception #1: Fixtures rated 4 watts or less, employing lamps rated 1.2 watts or less.

Exception #2: OEM light fixtures that are reinstalled on their original factory circuit.

7-3.1.1 Light fixtures requiring listing under 7-3.1 in all recreational vehicles shall be de-energized when the lens or the bulb comes within 1" (25.4 mm) of contact with material of a movable bed or section of the recreational vehicle having a flame-spread index of 26 or more when evaluated in accordance with ASTM E84 or UL 723.

7-3.1.2 Light fixtures requiring listing under 7-3.1 shall not be installed with the lens or the bulb within 18" directly above a mattress unless permitted by the listing or direct contact shielding is provided.

7-3.2 Appliances. Higher current-consuming, direct-current appliances, such as pumps, compressors, heater blowers, and similar motor-driven appliances, shall be installed in accordance with the appliance manufacturer's written instructions. Motors that are controlled by automatic switching or by latching-type manual switches shall be protected against overload in accordance with section 430.32(B), NFPA 70, National Electrical Code.

Chapter 8 Testing

8-1 Operational Test. An operational test of all low voltage circuits shall be conducted to demonstrate that all equipment is connected and in electrical working order. This test shall be performed after all production activities that may damage conductors, such as installation of fasteners or hole cutting, have been completed.

Chapter 9 Referenced Publications

9-1 General. The following documents or specific portions thereof are referenced within this standard. The edition indicated for each reference shall be the current edition as of the date of the ANSI issuance of this document.

9-2 SAE Publications. Society of Automotive Engineers, Inc., 400 Commonwealth Drive, Warrendale, PA 15096

SAE J258-2000, Circuit Breakers - Internal Mounted-Automatic Reset

SAE J553-2004, Circuit Breakers

SAE J554-1987, Standard for Electric Fuses (Cartridge Type)

SAE J561-2010, Electrical Terminals - Eyelet and Spade Types

SAE J771-2012, Automotive Printed Circuits

SAE J858(a)-2011, Electrical Terminals - Blade type

SAE J928-2010, Electrical Terminals - Pin and Receptacle Type

SAE J1284-1988, Electrical Terminals - Standard for Blade Type Electric Fuses

SAE J1127-2012, Battery Cable

SAE J1128-2013, Low Voltage Primary Cable

9-3 UL Publications. Underwriters Laboratories Inc., 333 Pfingsten Road, Northbrook, IL 60062.

UL 275-2013, Standard for Automotive Glass Tube Fuses

UL 723-2008, Standard Test Method for Surface Burning Characteristics of Building Materials

9-4 NFPA Publications. National Fire Protection Association. Batterymarch Park, Quincy, MA 02269.

NFPA 70 2014 National Electrical Code

9-5 ASTM Publications. ASTM International, 100 Barr Harbour Drive, P.O. Box C700, West Conshohocken, PA 19428-2959.

ASTM E84-13a, Standard Test Method for Surface Burning Characteristics of Building Materials

Appendix 1 Systems Not Covered

The following systems shall not be covered for purposes of this standard:

1. Speed control systems
2. Windshield wiping systems
3. Windshield defrosting systems
4. Headlamp systems
5. Hood latching systems
6. Braking systems
7. Steering systems
8. Throttle control systems
9. Transmission neutral start systems

Appendix 2 Conductor Sizing Table - Maximum 10% Voltage Drop - (12VDC)

NOTE: This is not part of the Low Voltage Electrical Standard.

Current Draw (Amps)

Gage	1	2	3	4	5	6	7	8	9	10	15	20	25	30	40	50	60	70	80	100
	MAXIMUM LENGTH OF SAE CONDUCTOR (in feet) FROM SOURCE TO DEVICE																			
20	107	53	36	27	21	18	15	13	12	11	7									
18	172	86	57	43	34	29	25	21	19	17	11	9								
16	261	130	87	65	52	43	37	33	29	26	17	13	10							
14	413	207	138	103	83	69	59	52	46	41	28	21	17	14						
12	651	326	217	163	130	109	91	81	72	65	43	33	26	22	16					
10	1043	521	348	261	208	174	149	130	116	104	70	52	42	35	26	21	17			
8	1653	827	551	413	331	276	236	207	184	165	110	83	66	55	41	33	28	24	21	
6	2892	1446	954	723	578	482	413	362	321	289	193	145	116	96	72	58	48	41	36	29
4	4170	2085	1390	1043	834	695	596	521	463	417	278	209	167	139	104	83	70	60	52	42
	MAXIMUM LENGTH OF AWG CONDUCTOR (in feet) FROM SOURCE TO DEVICE																			
20	115	57	38	29	23	19	16	14	13	11	8									
18	182	91	61	45	36	30	26	23	20	18	12	9								
16	288	144	96	72	58	48	41	36	32	29	19	14	12							
14	458	229	153	115	92	76	65	57	51	46	31	23	18	15						
12	729	364	243	182	146	121	104	91	81	73	49	36	29	24	18					
10	1159	579	386	290	232	193	166	145	129	116	77	58	46	39	29	23	19			
8	1738	869	579	435	348	290	248	217	193	174	116	87	70	58	43	35	29	25	22	
6	2930	1465	977	733	586	488	419	366	326	293	195	147	117	98	73	59	49	42	37	29
4	4659	2330	1553	1165	932	777	666	582	518	466	311	233	186	155	116	93	78	67	58	47

Appendix 3 Recreational Vehicle (RV)

The following explanatory material further describes types of Recreational Vehicles as defined in Section1-7.

The product types are motorhome and towable RV.

Motorhome. A recreational vehicle built on a self-propelled motor vehicle chassis. The product-type categories are as follows:

(1) Type A Motorhome. A motorhome constructed on a bare motor vehicle chassis.

(2) Type B Motorhome. A motorhome constructed on a automotive-manufactured van-type vehicle.

(3) Type C Motorhome. A motorhome constructed on a cut-away automotive-manufactured truck vehicle.

Towable RV. A recreational vehicle that is mounted on wheels and designed to be towed by a motorized vehicle or a portable unit that is designed to be placed in the bed of a pickup truck. The product-type categories are as followed:

(1) Fifth-Wheel Travel Trailer. A towable RV mounted on wheels and designed to be towed by a motorized vehicle by means of a towing mechanism that is mounted above or forward of the tow vehicle's rear axle.

(2) Folding Camping Trailer. A towable RV mounted on wheels and designed to be towed by a motorized vehicle that is constructed with a collapsible roof and collapsible partial sidewalls that unfold and extend in the set-up mode and fold back up for travel.

(3) Travel Trailer. A towable RV mounted on wheels and designed to be towed by a motorized vehicle that is constructed with a roof and sidewalls made of rigid materials.

(4) Truck Camper. A towable RV that is designed to be placed in the bed of a pickup truck.

Additional motorhome and towable RV products include the following:

(1) Expandable Travel Trailer. A travel trailer constructed of at least one collapsible partial sidewall that unfolds for additional sleeping space in the set-up mode and folds back up for travel.

(2) Horse (Livestock) RV. A motorhome or towable RV that contains a designated area for transporting horses (or other livestock).

(3) Sport Utility RV. A motorhome or towable RV that has an entrance door wider than 36 in. (0.91m) accessible by means of an access ramp or is promoted as having the ability to transport or store internal combustion engine vehicles or equipment.